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Special Issue: Cognitive Ecology

Twenty-five years of cognitive ecology



In the 25 years since the publication of *Toward a Cognitive Ecology* (Real, 1993), the then nascent field of cognitive ecology has blossomed and well borne out its promise to better integrate the study of animals' cognitive capabilities within an evolutionary and ecological framework. Herein, this special issue of *Animal Behaviour* brings together review articles written by a hand-picked selection of some of the foremost researchers investigating the evolutionary ecology of learning, memory and information use. In doing so, this collection demonstrates a breadth and depth of scientific inquiry greater than anticipated just a quarter century ago. As was the case for Reuven Dukas's (1998) edited text *Cognitive Ecology*, and its successor *Cognitive Ecology II* (Dukas & Ratcliffe, 2009), this special issue would not have been possible without the support of the Animal Behavior Society, which hosted the three symposia that were the staging grounds and springboards for these three publications. At the journal itself, we thank Executive Editor Susan Foster and Managing Editor Kris Bruner for their expert guidance and unwavering support from inception to completion.

We are, of course, most grateful to all of the authors who agreed to contribute to this special issue. This special issue consists of eight exemplary review articles, each of which we briefly summarize below. That said, the authors and articles speak for themselves, and, to a one, are excellent: we encourage would-be readers to skip directly to those pieces that pique their interest most.

Many of the seminal findings in the field emerge from the intersection of work on learning and memory by behavioural ecologists and the study of navigation in vertebrates – asking, for example, how learning and its mechanisms shape foraging behaviour. This tradition continues to offer new insights, and is well represented in the current volume. In the first paper in this special issue, 'Spatial memory and cognitive flexibility trade-offs: to be or not to be flexible, that is the question', Vladimir Pravosudov and colleagues explore the benefits of forgetting and the neural mechanisms that mediate such erasure. While cognitive flexibility is generally considered valuable to animals living in variable environments, the authors suggest that previously stored memories may interfere with the acquisition of new information, and, in turn, that forgetting may be both necessary and adaptive. This pioneering work brings these questions to measures of memory in wild populations of chickadees.

Julie Morand-Ferron and colleagues describe how environmental variation and the predictability of food resources interact to shape cognitive specializations. Their contribution, 'Environmental variability, the value of information, and learning in winter residents', examines specifically how altitude and urbanization

covary with learning performance in great tits, *Parus major*, and black-capped chickadees, *Poecile atricapillus*. They find that simple models emphasizing differences in the predictability or harshness of the environment are not always predictive of learning specializations. The results they present suggest a role for social and temperament differences as well.

In 'Behaviour shapes environmental variation and selection on learning and plasticity: review of mechanisms and implications', Emily Snell-Rood and Meredith Steck deftly combine theory and empirical data to set a well-grounded stage supporting the role of environmental variation in selecting cognitive abilities in animals. Upon this they argue that behavioural and physiological traits influence how environmental variation is experienced by individuals, and that this may influence how plasticity evolves. Using examples from habitat choice and exploration, sensory bias and dispersal, Snell-Rood and Steck demonstrate that natural selection tends to favour specialization in heterogeneous environments. In closing they call for more research into developmental and genetic influences on cognitive traits in the face of novel and changing environments.

The study of environmental variation and predictability have long been central to the study of animal cognition, but as illustrated by the contents of this issue, theoretical and empirical perspectives are not always aligned. Aimee Dunlap and colleagues describe work using agent-based models and experimental evolution to investigate adaptation to temporal and spatial variation in the environment, both within and across generations. In their review, 'Components of change and the evolution of learning in theory and experiment', they synthesize these findings with empirical studies of bumblebee foraging in the wild.

In the Anthropocene, one ever-present source of environmental variability is the effect we humans have on the natural world. Since the pioneering work of Lefebvre and colleagues, foraging innovation, behavioural flexibility and brain size have been linked to the success of species in urban environments (Lefebvre, Reader, & Sol, 2004). Sarah Benson-Amram and co-authors provide a creative new perspective on 'The cognition of "nuisance" species'. Their review acknowledges that behavioural flexibility allows some species to thrive in the face of altered environments, and yet this very success sometimes puts them into conflict with humans. Elephants use tusks to by-pass electric fences; social transmission of learned behaviour can allow geese to raid crops; and behaviourally plastic animals can modify a variety of manufactured items into nest sites. In contrast, many aspects of behavioural plasticity may allow animals to avoid conflict – avoiding areas that are highly developed or that have heavy traffic. The review provides a novel and

thoughtful overview of the many ways that cognitive ecology impacts the animals that increasingly live alongside us.

In 'Culture and cultural evolution in birds: a review of the evidence', Lucy Aplin knowledgeably surveys an ever-growing body of research supporting cultural behaviour in nonhuman animals, then focuses in on the cultural life and cultural evolution in birds. She then challenges the idea that social learning and cultural transmission are limited to all but a narrow aspect of birds' behavioural repertoires, namely vocal learning, and discusses the evidence in support of culture in a variety of domains in the social lives of birds within a conceptual framework. Zooming back out again, Aplin then considers how a more cultural perspective could prove informative in work on cognitive ecology more broadly.

In addition to cultural learning, foraging and navigation, the study of mate choice has become an increasingly rich source of insights into the decision mechanisms that underlie natural behaviours. Work that began at the sensory periphery, with studies of 'sensory bias' and 'sensory exploitation', has begun to examine higher-level aspects of decision processes. In "'Crazy love": nonlinearity and irrationality in mate choice', Mike Ryan and colleagues challenge a common assumption of how such decisions are executed – that is, that mating decisions are economically 'rational'. Rationality posits that preferences are stable across contexts and the options provided. Using frogs as models, this review also illuminates several instances of unexpected overlap between amphibians and humans with respect to irrational choice, including the influence of competitive decoys.

The final contribution is a broad and somewhat speculative entry by a pioneer in cognitive ecology, Reuven Dukas. In 'Animal expertise: mechanisms, ecology and evolution', the author defines expertise as the gradual accumulation of skills that lead to superior performance on a frequently encountered task. The literature that

exists is predominantly on the acquisition of expertise in humans, but Dukas argues that frequently encountered tasks in the natural world might similarly lead to improvements in response times, in accuracy, and in fine motor performance relevant to the life history of a species. The analogy suggests novel areas of research for the field, including motivation and perseverance, and the extent to which expertise might free cognitive resources for other uses.

Overall the issue reveals that after a quarter century, the field of cognitive ecology is thriving. It offers new perspectives on long-standing questions as well as new behaviours to explore. It reflects the increased prominence of topics like animal personality and neuroscience within animal behaviour more generally. Most of all, it illustrates how the integrative study of behaviour, mechanism and adaptation can provide a more complete picture of animal behaviour and its remarkably captivating diversity.

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Guest Editors

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